National Healthcare Safety Network (NHSN) Antimicrobial Use and Resistance (AUR) Reporting and the Standardized Antimicrobial Administration Ratio (SAAR)

Daniel A. Pollock, M.D
Surveillance Branch Chief
Division of Healthcare Quality Promotion
National Center for Emerging and Zoonotic Infectious Diseases
Centers for Disease Control and Prevention

2nd Annual Houston Antimicrobial Stewardship Symposium
Crowne Plaza Houston Near Reliant - Medical
Houston, TX - March 24, 2016

CDC's Role in Healthcare-Associated Infection (HAI) Surveillance – Some Major Milestones

1957-58	Investigative unit formed to assist hospitals with their responses to outbreaks of antibiotic-resistant staphylococcal infections
1965-66	HAI surveillance pilot projects at six hospitals
1970	National Nosocomial Infection Surveillance (NNIS) system launched with 62 participating hospitals
1974-83	Nationwide Study of the Efficacy of Nosocomial Infection Control (SENIC) project
1992	Healthcare Infection Control Practices Advisory Committee (HICPAC) established
2005	National Healthcare Safety Network (NHSN) goes live as the successor to the NNIS system
2011	AUR Module added to NHSN

CDC Turns 70 on July 1, 2016 – Successor Agency to the Federal Office of Malaria Control in the War Areas (MCWA)

CDC first occupied the old MCWA offices in downtown Atlanta

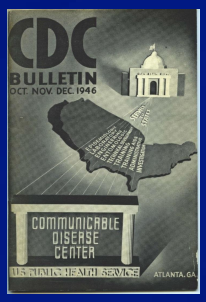
MCWA had worked to control malaria around military bases in the South during WWII

Overview

- Begin with some context-setting observations about CDC's National Healthcare Safety Network (NHSN) and clinical quality measurement
- Describe antimicrobial use and resistance (AUR) surveillance via NHSN, focusing on the AU reporting option
- Summarize the Standardized Antimicrobial Administration Ratio (SAAR), which is the quantitative centerpiece of NHSN's new AU measure
- Conclude with some next steps for AU surveillance and the NHSN AU measure

Post-World War II Malaria Control: CDC and States Join Forces on National Surveillance

- CDC's first post-war mission was to spearhead a large-scale campaign to eradicate malaria
- CDC and States launched national surveillance in 1950, several years after the eradication program began
- Data revealed that malaria had quietly disappeared prior to eradication efforts but then spiked in 1951-52 among returning Korean War veterans
- Malaria experience was the impetus for national surveillance of polio (1955), influenza (1957), and then dozens of other diseases



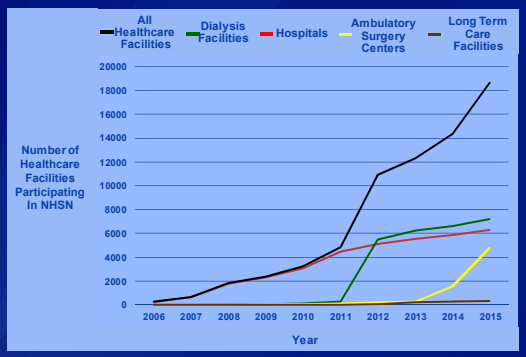
CDC's National Healthcare Safety Network (NHSN) – A Multi-Partner, Multi-Purpose Surveillance System

Healthcare facilities: (1) Join NHSN, (2) complete an annual survey of their care capacities, (3) submit process and outcome data manually or electronically to one or more NHSN components, and (4) use their own data and NHSN benchmarks for analysis and action

- Patient Safety Component
- Healthcare Worker Safety Component
- Dialysis Component
- Blood Safety Component
- Long Term Care Component
- Neonatal Component (Planned)
- Outpatient Procedure Component (Planned)

CDC: Collects, analyzes, summarizes, and provides data on HAIs, other adverse healthcare events, antimicrobial use and resistance, adherence to prevention practices, and use of antimicrobial stewardship programs

NHSN: Growth in Facility Participation, 2006-2015



National Healthcare Safety Network Antimicrobial Use Measure – NQF 2720

Current and Planned Use of the Measure:

- ☑ Public health/disease surveillance
- ☑ Quality improvement (internal to the specific organization)
- ☑ Quality improvement (external benchmarking involving multiple organizations)
- ☐ Public reporting
- ☐ Payment program
- ☐ Regulatory and accreditation programs
- ☐ Professional certification or recognition program

CDC Reports Hospital-Specific HAI Event Data to the Centers for Medicare and Medicaid Services (CMS)

HAI Event	Hospital Type	Start Date
CLABSI	Acute Care Hospitals - ICUs	2011
	Long Term Care Hospitals	2012
	Cancer Hospitals	2013
	Acute Care Hospitals ï Ward locations	2015
CAUTI	Acute Care Hospitals - ICUs	2012
	Long Term Care Hospitals	2012
	Inpatient Rehabilitation Facilities	2012
	Cancer Hospitals	2013
	Acute Care Hospitals ï Ward locations	2015
SSI ï colon surgery and abdominal hysterectomy	Acute Care Hospitals - ICUs	2012
	Cancer Hospitals	2014
MRSA Bacteremia LabID Event	Acute Care Hospitals	2013
	Long Term Care Hospitals	2015
	Inpatient Rehabilitation Facilities	2015
	Cancer Hospitals	2016
C. Difficile LabID Event	Acute Care Hospitals	2013
	Long Term Care Hospitals	2015
	Inpatient Rehabilitation Facilities	2015
	Cancer Hospitals	2016
Ventilator Associated Event	Long Term Care Hospitals	2016

Antimicrobial Use and Resistance (AUR) Module – The Basics

- Designed to support healthcare and public health efforts to:
  - (1) Monitor and improve antimicrobial prescribing
  - (2) Identify, understand, and respond to antimicrobial resistance patterns or trends
- Provides a common set of technical specifications and a single surveillance platform for hospitals to report AU and AR data
- All data must be submitted electronically to the AUR Module
- Data that are successfully transmitted are available immediately to NHSN users for analysis and visualization
- Summary data provide AU and AR benchmarks that hospitals, healthcare systems, and public health agencies can use for comparative purposes and as a guide for further analysis and action

ñ. . . . the measurement fad has spun out of control . . . We need more targeted measures, ones that have been vetted to ensure they really matter . . . for example, measuring the rates of certain hospital-acquired infections has led to greater emphasis on prevention and has most likely saved lives.ò

The New York Times January 17, 2016

Robert Wachter


How Measurement Fails Us

NHSN AU Reporting Option: Operational Overview

Participation:
- General acute care hospitals, long-term acute care hospitals, inpatient rehabilitation facilities, oncology hospitals, critical access hospitals

Data Sources:
- Electronic Medication Administration Record (eMAR) or Bar Coding Medication Administration (BCMA) systems for AU data
- Admission/Discharge/Transfer (ADT) systems for patient location data

Monthly Numerator Data:
- Antimicrobial days ï Days of therapy for a specified antimicrobial agent administered in a patient care location
- 89 antimicrobials are in scope - Antibacterial, antifungal, and anti-influenza agents, stratified by route of administration (intravenous, intramuscular, digestive, and respiratory)

Monthly Denominator Data:
- Days present ï Number of patients in a specific location or facility, per day, aggregated for a monthly total.
- Admissions ï Number of patients admitted to the hospital

AU Data Flow From Bedside to NHSN

eMAR/BCMA and ADT Systems

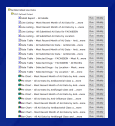
Extract, transform and load AU data by means of a vendor or homegrown IT solution

- Monthly summary data
- 89 antimicrobials
- Location specific
- Days present and admissions

Submit AU data using standard file format

NHSN Servers

Local AU data access via NHSN's web interface



Analysis, visualization, and reporting AU data

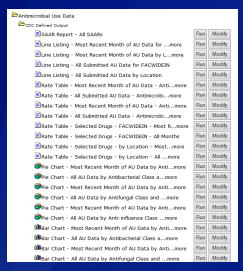
Interpreting SAAR values

SAAR values are always greater than 0, and a value of 1.0 suggests equivalency between observed and predicted AU.

- A high SAAR (above 1.0) that achieves statistical significance (i.e., different from 1.0) may indicate excessive AU
- A SAAR that is not statistically different from 1.0 indicates AU is equivalent to the referent population's AU
- A low SAAR (below 1.0) that achieves statistical significance (i.e., different from 1.0) may indicate antimicrobial under use

Note: A SAAR above 1.0 that does not achieve statistical significance may be associated with excessive AU and warrant further investigation. Also, a SAAR that differs statistically from 1.0 does not assure that further investigation will be productive.

AU Option – NHSN Analysis Output Options



Basic analysis output options available

- Line lists
- Rate tables
- Pie charts
- Bar charts
- SAAR (Standardized Antimicrobial Administration Ratio)

NHSN Patient Care Locations for SAAR calculations

- The NHSN AU Measure is comprised of 16 SAARs, each of which summarizes AU for a specified combination of patient care locations and antimicrobial agents.
- The patient care locations are:
  1. Adult medical, surgical, and medical/surgical *intensive care units*
  2. Adult medical, surgical, and medical/surgical *wards*
  3. Pediatric medical, surgical, and medical/surgical *intensive care units*
  4. Pediatric medical, surgical, and medical/surgical *wards*
  5. All adult medical, medical/surgical, and surgical *intensive care units and wards*
  6. All pediatric medical, medical/surgical, and surgical *intensive care units and wards*

Standardized Antimicrobial Administration Ratio (SAAR) – The Basics

- The SAAR is the quantitative linchpin of the NHSN AU Measure; it summarizes AU in the form of an observed-to-predicted ratio:
  - *Numerator* – Observed days of therapy reported by a healthcare facility for a specified category of antimicrobial agents used in a patient care location or group of locations
  - *Denominator* – Days of therapy predicted for a healthcare facility's use of a specified category of antimicrobial agents in a patient care location or group of locations, calculated by applying negative binomial regression modeling to nationally aggregated AU data
- SAAR values can serve as a starting point for medication use evaluations by antimicrobial stewardship programs, but SAAR values are not definitive measures of judiciousness or appropriateness

Antibacterial Agent Categories Used for SAAR Calculations

High value targets for antimicrobial stewardship programs:

1. *Broad spectrum agents predominantly used for hospital-onset/multi-drug resistant bacteria* – aminoglycosides, some carbapenems, some cephalosporins, some fluoroquinolones, penicillin B-lactam/b-lactamase inhibitor combinations, and other agents
2. *Broad spectrum agents predominantly used for community-acquired infection* – ertapenem, some cephalosporins, and some fluroquinolones
3. *Anti-MRSA agents* – ceftaroline, dalbavancin, daptomycin, linezolid, oritavancin, quinupristin/dalfopristin, tedizolid, telavancin, in, and vancomycin (IV route only)
4. *Agents predominantly used for surgical site infection prophylaxis* – cefazolin, cefotetan, cefoxitin, cefuroxime

High level indicators for antimicrobial stewardship programs:

5. *All antibacterial agents* – All agents included in NHSN AUR protocol

NHSN AU Measure – SAARs for High Value Targets

SAARs for broad spectrum antibacterial agents predominantly used for hospital-onset/multidrug resistant infections:

1. Adult medical, medical/surgical, and surgical ICUs
2. Adult medical, medical/surgical, and surgical wards
3. Pediatric medical, medical/surgical, and surgical ICUs
4. Pediatric medical, medical/surgical, and surgical wards

SAARs for broad spectrum antibacterial agents predominantly used for community-acquired infections:

5. Adult medical, medical/surgical, and surgical ICUs
6. Adult medical, medical/surgical, and surgical wards
7. Pediatric medical, medical/surgical, and surgical ICUs
8. Pediatric medical, medical/surgical, and surgical wards

SAARs for anti-MRSA antibacterial agents:

9. Adult medical, medical/surgical, and surgical ICUs
10. Adult medical, medical/surgical, and surgical wards
11. Pediatric medical, medical/surgical, and surgical ICUs
12. Pediatric medical, medical/surgical, and surgical wards

SAARs for antibacterial agents predominantly used for surgical site infection prophylaxis:

13. Adult ICUs and wards (medical, medical/surgical, and surgical)
14. Pediatric ICUs and wards (medical, medical/surgical, and surgical)

NHSN SAAR Distributions and Statistical Comparisons – Adult Patients, High Value Targets for Stewardship

NQF Reporting Measure	No. of Patient Care Locations	Mean SAAR	Median SAAR	SAAR statistically lower than 1 N (%)	SAAR statistically higher than 1 N (%)
High Value Targets					
Adult High Value Target 1: Broad spectrum antibacterial agents predominantly used for hospital-onset/multi-drug resistant infections ï adult medical, medical/surgical, and surgical intensive care units	100	1.013	0.914	52 (52%)	37 (37%)
Adult High Value Target 2: Broad spectrum antibacterial agents predominantly used for hospital-onset/multi-drug resistant infections ï adult medical, medical/surgical, and surgical wards	250	0.988	0.983	108 (43%)	99 (40%)
Adult High Value Target 3: Broad spectrum antibacterial agents predominantly used for community-acquired infections ï adult medical, medical/surgical, and surgical intensive care units	100	0.988	0.924	47 (47%)	32 (32%)
Adult High Value Target 4: Broad spectrum antibacterial agents predominantly used for community-acquired infections ï adult medical, medical/surgical, and surgical intensive care wards	250	0.999	0.956	118 (47%)	97 (39%)
Adult High Value Target 5: Anti-MRSA-antibacterial agents ï adult medical, medical/surgical, and surgical intensive care units	100	1.000	0.971	43 (43%)	33 (33%)
Adult High Value Target 6: Anti-MRSA-antibacterial agents ï adult medical, medical/surgical, and surgical wards	250	0.992	0.965	116 (46%)	95 (38%)
Adult High Value Target 7: Antibacterial agents predominantly used for surgical site infection prophylaxis ï all adult medical, medical/surgical, and surgical locations (intensive care units and wards)	74	1.250	0.981	35 (47%)	30 (41%)

NHSN AU Measure – High Level Indicator SAARs

SAARs for all antibacterial agents:

15. Adult ICUs and wards (medical, medical/surgical, and surgical)
16. Pediatric ICUs and wards (medical, medical/surgical, and surgical)

SAAR Output in NHSN*

National Healthcare Safety Network

SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets

As of: November 17, 2015 at 3:10 PM

Date Range: All AU_SAAR

SAAR title

All antimicrobials used in adult ICUs and wards

Denominator

Facility Org ID	Summary Yr/Qtr	SAAR Type	Antimicrobial Days	Predicted Antimicrobial Days	Days Present	SAAR	SAAR p-value	95% Confidence Interval
13860	2014Q1	IND-Adult-1	4416	4421.364	6326	0.999	0.9437	0.970, 1.029
13860	2014Q2	IND-Adult-1	3998	3856.677	5668	1.037	0.0240	1.005, 1.069
13860	2014Q3	IND-Adult-1	3568	3952.912	5765	0.903	0.0000	0.873, 0.933
13860	2014Q4	IND-Adult-1	6835	5731.061	9247	1.193	0.0000	1.166, 1.221
13860	2015Q1	IND-Adult-1	4060	3113.877	5358	1.304	0.0000	1.264, 1.344

Observed Use

Predicted Use

Calculated SAAR Values

Includes data for January 2014 and forward

Data restricted to medical, medical/surgical and surgical locations.

Source of aggregate data: 2014 NHSN AU Data

Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

*Synthetic data, for example only

SAAR Predictive Models Include Hospital and Patient Location Variables

Broad Spectrum Agents Predominantly Used for Hospital-Onset/multi-drug resistant infections

- ICU, 4-way location-type variable (Levels: Medical Unit, Medical/Surgical Unit, Surgical Unit, Pediatric Unit*)

Broad Spectrum Agents Predominantly Used for Community Acquired infections

- Teaching Status, ICU, Pediatric Location

Anti-MRSA Agents

- ICU, 4-way location-type variable (Levels: Medical Unit, Medical/Surgical Unit, Surgical Unit, Pediatric Unit*), Interaction Term: ICU and 4 way location-type variable

Agents Predominantly Used for Surgical Site Infection Prophylaxis

- ICU, Surgical Location

All Agents

- ICU, 4 way location-type variable (Levels: Medical Unit, Medical/Surgical Unit, Surgical Unit, Pediatric Unit*)

**Referent group in a multi-way variable*

NHSN AU Data Submission Metrics

132 hospitals have submitted at least 1 month of AU data from 2011 – 2016*

- From 30 states: AZ, CA, CO, CT, FL, IA, ID, IL, IN, KS, KY, MA, MI, MN, MO, NC, ND, NE, NM, NY, OH, OK, OR, RI, SD, TN, TX, UT, VA, WI
- Hospital bed size: Average = 225, Median = 208, Min/Max = 11, 919
- Teaching hospitals = 61%; Major teaching hospitals = 56%

AU Data from 43 hospitals submitted for calendar year 2014 were used to develop the SAAR predictive models

*As of January 2016

Next Steps for AU Surveillance and the NHSN AU Measure

- Increase hospital participation in the AU reporting option
  - Technical assistance and funding for AU option implementations
  - Collaborations with hospitals and healthcare systems that submit AU data and use the data in their antimicrobial stewardship programs
  - Follow through on federal interagency plans to include AU and AR reporting to NHSN in the Meaningful Use Stage 3 incentive program for electronic health record systems
- Use field experience, additional AU data collection, and systematic studies to enhance the SAAR predictive models
- Work on a second iteration of the NHSN AU Measure that will enable the measure to be used for public reporting and other accountability purposes

Thank You!

Please contact me at dap1@cdc.gov

For more information about NHSN:
http://www.cdc.gov/nhsn

Division of Healthcare Quality Promotion
National Center for Emerging and Zoonotic Infectious Diseases